FaCT project

A brief overview of
the Fast Reactor Cycle Technology Development project

Advanced Nuclear System Research and Development Directorate
Japan Atomic Energy Agency

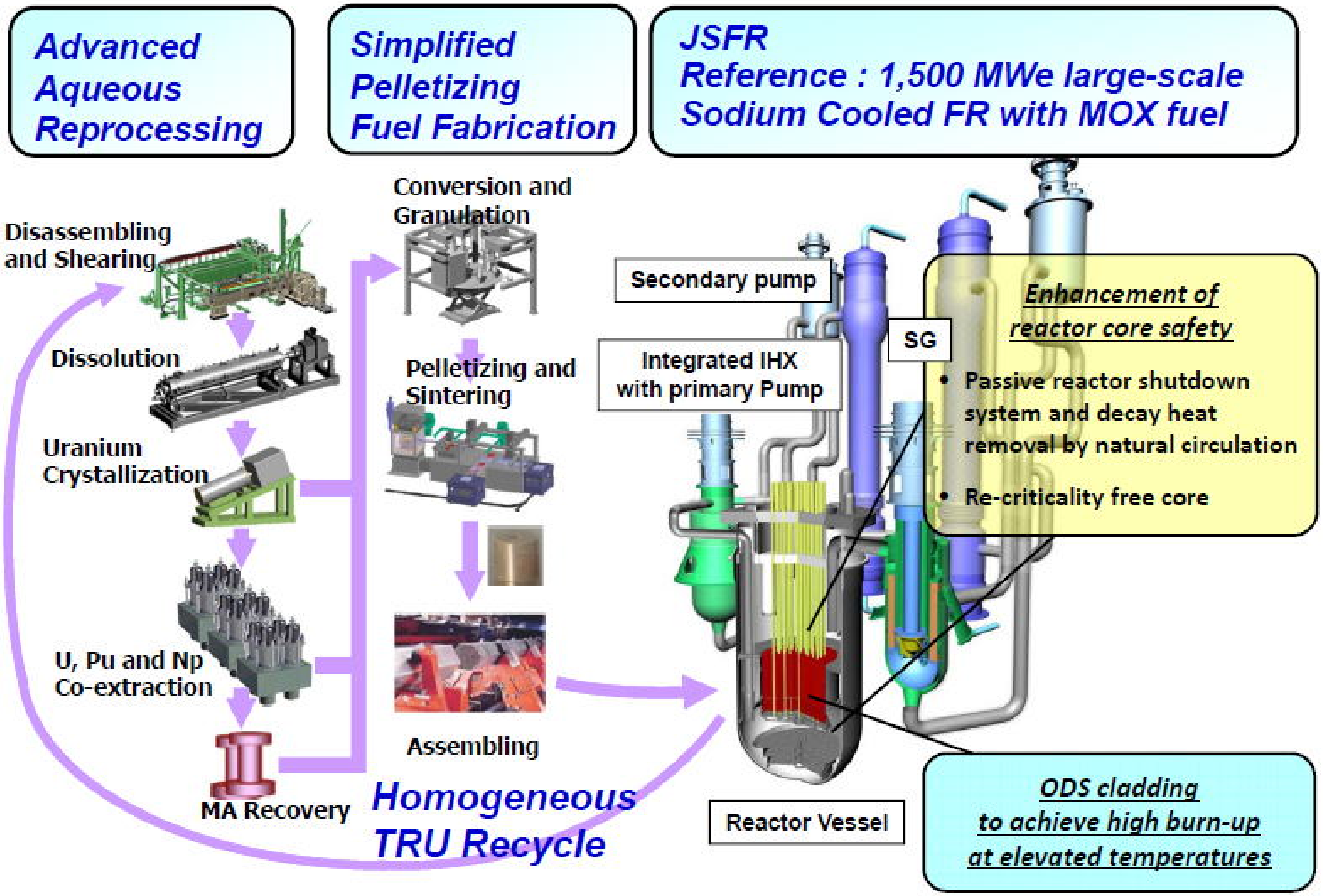
From Yutaka SAGAYAMA, Director General
(Chairman of the Generation IV International Forum, GIF)

<u>What do we do for addressing long-term energy security and global environmental issues?</u>

Thank you very much for visiting the web page of Advanced Nuclear System Research and Development Directorate.
At our directorate, we are promoting FaCT (Fast Reactor Cycle Technology Development) Project aiming at the commercialization of Sodium-cooled FBR which will contribute to effective use of limited uranium resources, reduction of long-lived nuclides such as americium and other minor actinides.
We promote R&Ds effectively and efficiently in cooperation with Oarai R&D Center, Nuclear Fuel Cycle Engineering Laboratories (of Tokai R&D Center) and Fast Breeder Reactor (FBR) R&D Center (in Tsuruga) and by international cooperation positive activities aiming at the commercialization of FBR cycles.
Our achievements of R&Ds will contribute to the sustainable development of society through the stages of technological demonstration and commercialization.

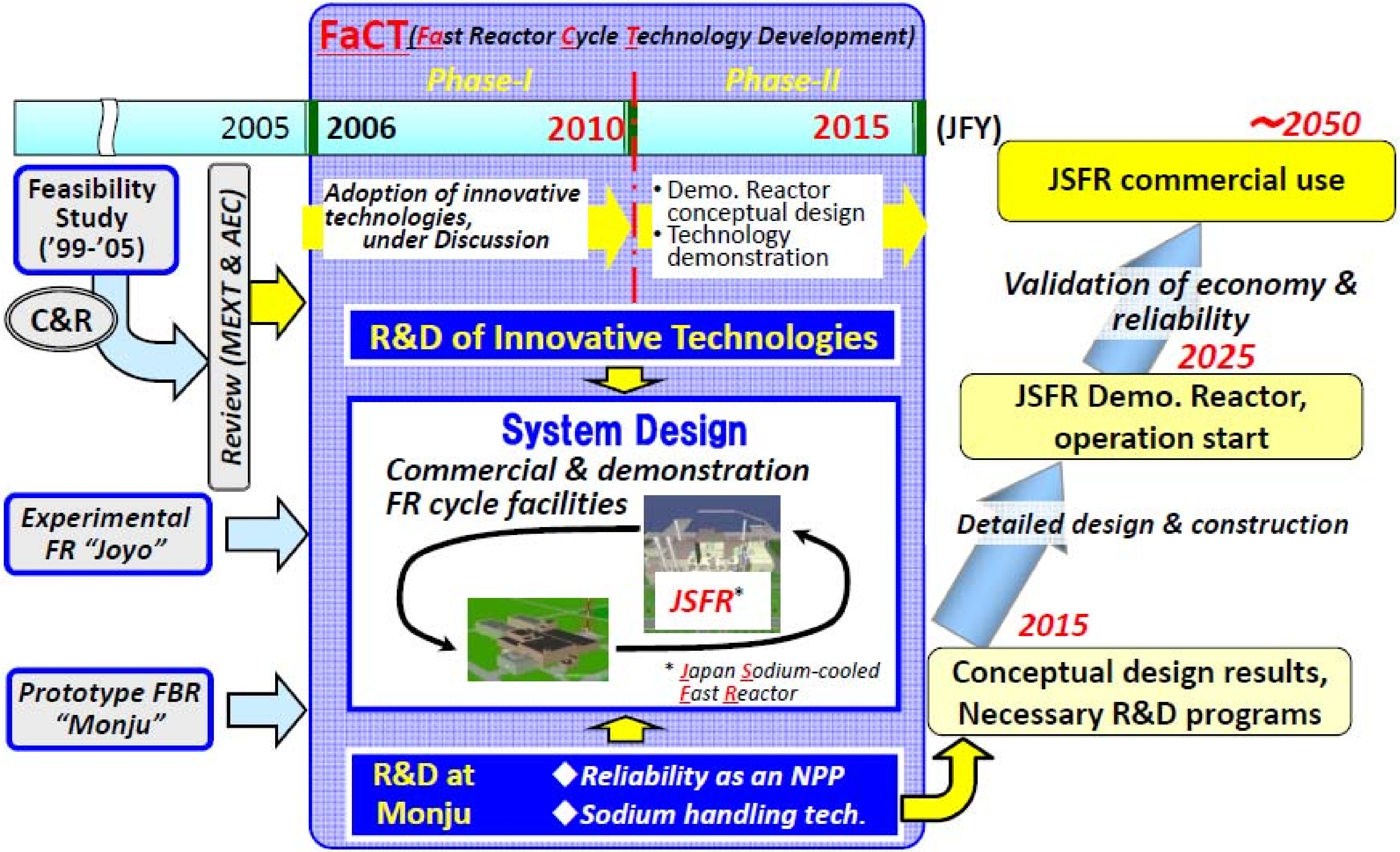
Overview of the FaCT project

We are developing the fast reactor and its fuel cycle system with a combination of the sodium-cooled FBR utilizing oxide fuel, advanced aqueous reprocessing, and the simplified pelletizing fuel fabrication. The technologies presently seem to have the best practical prospects for fostering economic competitiveness, safety, efficient use of resources, reduction of environment load, and non-proliferation, based on their performance in existing facilities.

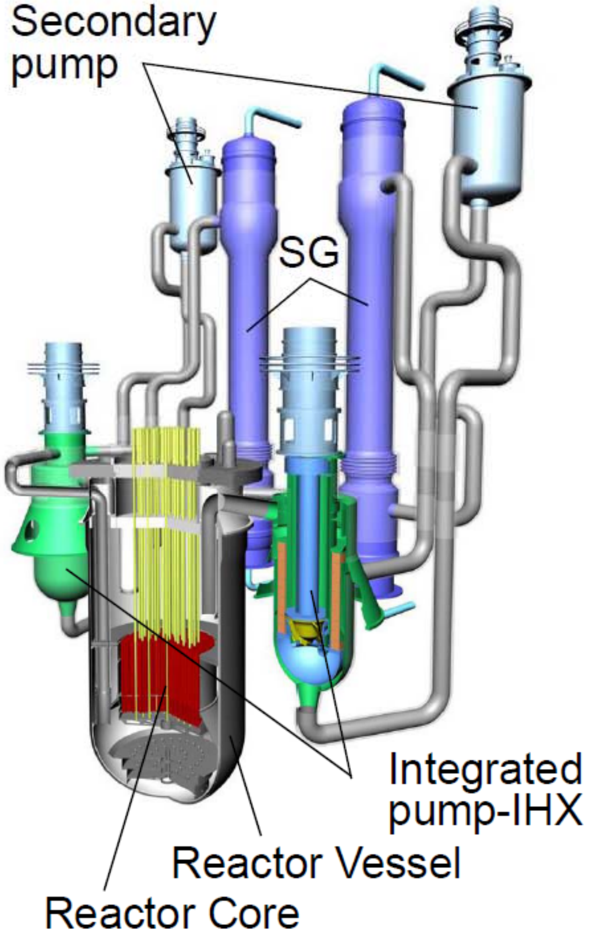


FaCT roadmap: Outline of FaCT project

Aiming for the start-up of a demonstration fast reactor (FR) around 2025 and its introduction on a commercial basis before 2050, Japan Atomic Energy Agency (JAEA) is now promoting its "Fast Reactor Cycle Technology Development (FaCT)" project.



General specification of the JSFR



Items	Specifications
Thermal/Electric Output	3,530MWt / 1,500MWe
Number of loops	2
Primary sodium temperature	550 /395 ºC
Secondary sodium temperature	520 / 335 ºC
Main steam temperature and pressure	497 ºC 18.7 MPa
Feed water temperature	240 ºC
Thermal efficiency of plant	approx. 42%
Fuel type	TRU-MOX
Fuel Burnup	150 GWd/t (core average)
Breeding ratio	Break even (1.03) ～ 1.2
Cycle length	18 - 26 months, 4 batches

Evaluation Results of Innovative Technologies for Reactor System

In 2010, a judgment by JAEA and JAPC on whether the innovative technologies should be adopted was made, focusing on the above-mentioned main concept. To evaluate the sodium-cooled fast reactor (with MOX fuel) in terms of its design adequacy as a reactor system, 13 tasks of the innovative technologies were reduced to 10 tasks to fit more precisely with the targeting evaluation technology. As the result, 9 tasks were rated as adoptable. However, for a steam generator with double-walled straight tube, it was judged that heat exchanger tube with a protective tube should be selected as an alternative technology.

- **Found 9 of 10 technologies are suitable for installation to the demonstration/ commercial reactors.**
- **ODS steel will be conducted further evaluation on manufacturing with stable quality until 2013.**

Plant constituent parts	Key technologies	
Safety	SASS, re-criticality free core	◎
Core and Fuel	High burn-up fuel with ODS cladding material	○
Reactor System	Compact reactor system	◎
Cooling System	Two-loop cooling system of large diameter piping made of Mod. 9Cr-1Mo steel	◎
	Integrated IHX/Pump component	◎
	Highly Reliable SG with double-walled straight tube	◎
DHRS	Natural convection DHRS	◎
BOP	Simplified fuel handling system	◎
Reactor Building	CV made of steel-plate-reinforced concrete (SCCV)	◎
	Advanced seismic isolation system for SFR	◎

◎: adoptable, ○: further R&D needed for judgment, No: not adoptable

1500 MWe JSFR
(for design study in JFY2010)

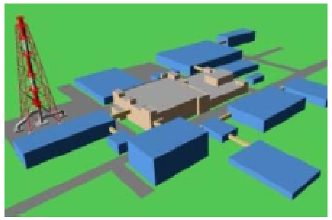
Evaluation Results of Innovative Technologies for Fuel Cycle System

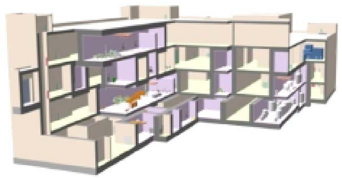
For advanced aqueous reprocessing, 3 tasks of the innovative technologies were rated as adoptable. And, it was judged that the evaluation of other 3 tasks (i.e., effective uranium recovery system by crystallization technology, MA recovery technology by extraction chromatography method, waste reduction technology or waste polarizing technology) should be continued.
For simplified pelletizing fuel fabrication, 3 tasks of the innovative technologies were rated as adoptable. And, it was judged that the evaluation of other 2 tasks (i.e., sintering and O/M ratio adjustment technique, in-cell remote handling technology) should be continued.

- **Found 3 of 6 technologies for reprocessing, and 3 of 5 for fuel fabrication are suitable for installation to the commercial plant.**
- **The remaining 3 technologies for reprocessing and 2 for fuel fabrication will be evaluated after obtaining further detailed data.**

Reprocessing

- Disassembling/shearing technologies ◎
- High efficiency dissolution technology ◎
- Effective uranium pre-recovery system by crystallization ○
- High effective extraction with group separation of U, Pu and Np ◎
- MA recovery technology by Extraction chromatography process ○
- Technology for reducing the amount of waste (liquid waste polarization using salt-free reagents) ○


Appearance of integrated reprocessing/fuel fabrication facility


Main process building (for design study in JFY2010)

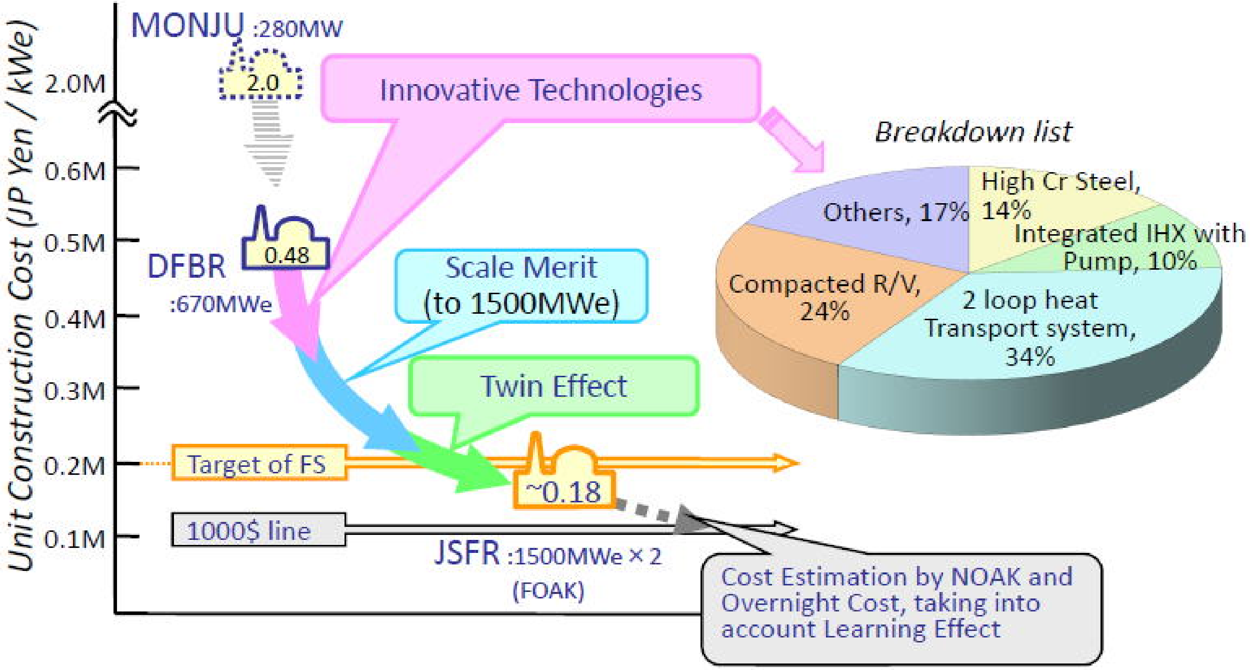
Fuel fabrication

- Unified process technology for denitration, calcination & reduction, as well as granulation ◎
- Die wall lubrication pelletizing technology ◎
- Sintering and O/M adjustment technologies ○
- In-cell remote handling equipment ○
- TRU-containing fuel handling technology ◎

◎: adoptable, ○: further R&D needed for judgment, No: not adoptable

Improvement of Economics for JSFR

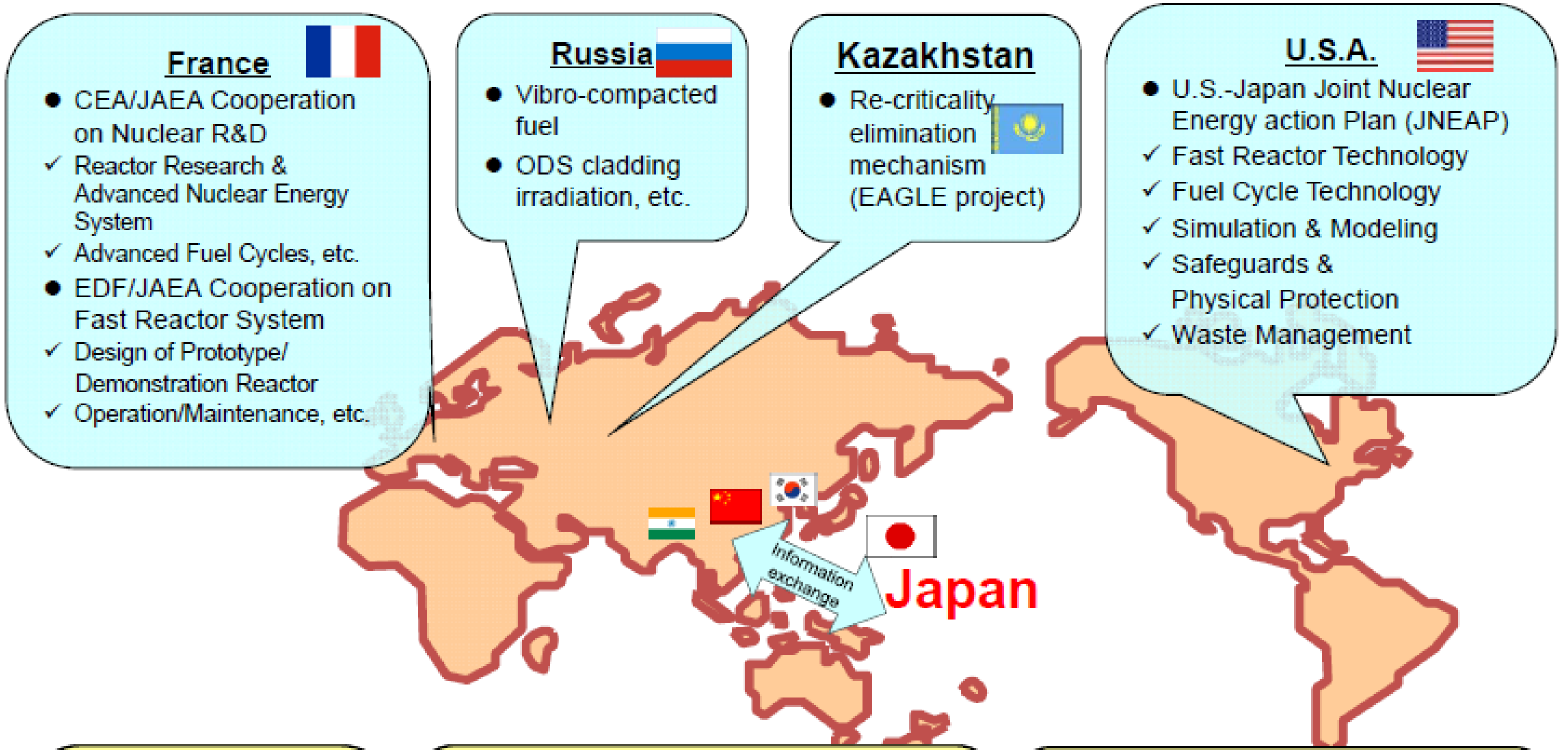
A construction cost is significant to evaluate economics for SFR. Based on the past experiences, the construction cost of prototype fast breeder reactor MONJU (280MWe) can be evaluated as 2 Million yen/kWe. After that, DFBR (670MWe) deign study was performed and reached to around 0.48 Million yen/kWe. Drastic Reduction of construction cost could be achieved by introducing the innovative technologies. Namely, **adoption of large piping using high Cr steel, reduction of loop number, compact design of reactor structure, and integration of components.** Moreover, plant concept should be enlarged to 1500MWe for pursuing scale merit. Standardization and learning effect are also taken into account. As a result, the construction cost of JSFR is estimated at approximately 0.18 Million yen/kWe for FOAK(first of a kind) plant. The cost estimation for the NOAK(Nth of a kind) plant with overnight cost condition by taking into account of learning effect will reach to the **1000$/kWe** line.



The unit construction cost of Monju is expressed as the construction cost divided by electric power.
The unit construction cost of DFBR and JSFR are evaluated value

International collaboration

We have been recognized the importance of international standardization of SFR safety criteria by use of multilateral cooperation. In accord with the partnership with INPRO and GIF, we are promoting the JSFR R&D under bi- and trilateral collaboration in order to use resources effectively and efficiently and to reduce risks in the development.



IAEA

- ➢ INPRO
- ➢ TWG-Fast Reactors
- ➢ TWG-Nuclear Fuel Cycle Options

GIF

- ➢ Sodium-cooled FR
- ➢ Gas-cooled FR
- ➢ Very High Temperature Reactor
- ➢ Super Critical Water Reactor
- ➢ Lead-cooled FR
- ➢ Molten Salt Reactor

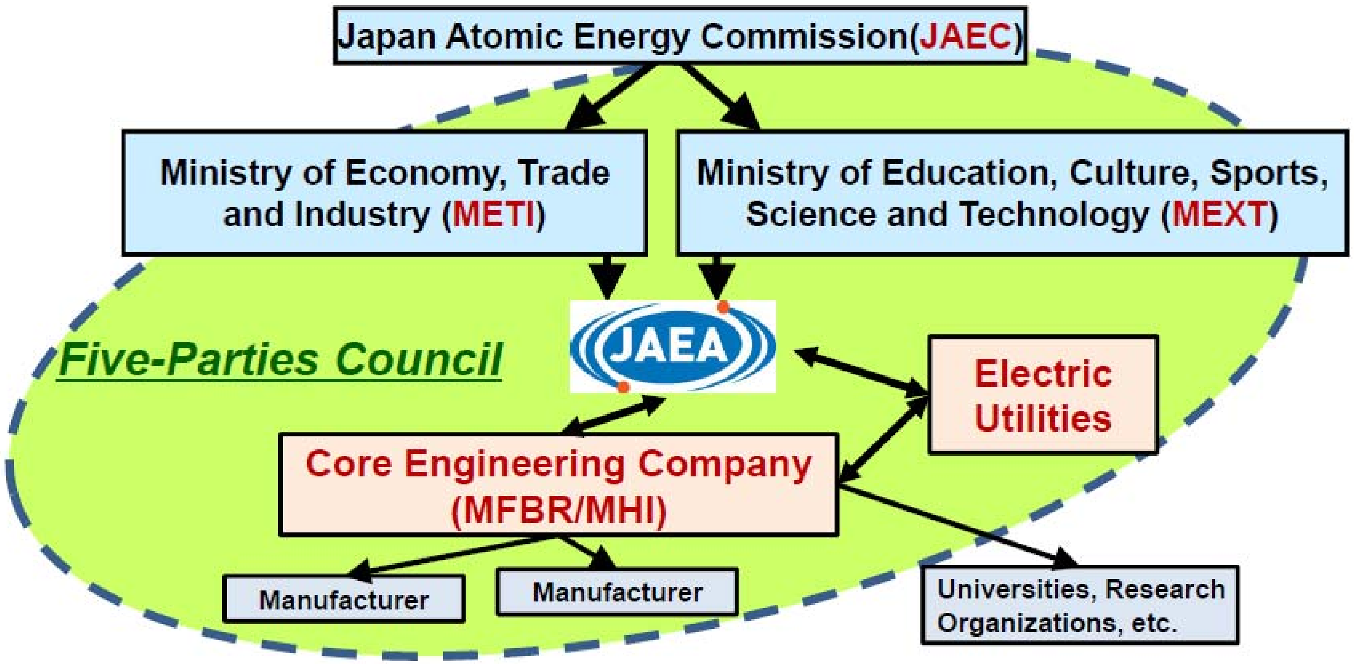
(Sodium-cooled FR, Gas-cooled FR, Very High Temperature Reactor: JAEA)

Trilateral Collaboration

- ➢ Sodium-Cooled FR
  - ✓ design goals and high level requirements for the prototypes
  - ✓ common safety principles
  - ✓ infrastructure needs, etc.
- ➢ Irradiation test of MA bearing fuels (GACID project in GIF)

Five-party council

We are promoting the FaCT project under the frame work of so called Five-party council. This figure shows the relationship between JAEA, MFBR and the related organization. MHI established the new company "Mitsubishi FBR Systems Inc.(MFBR)" for designing and engineering for FBR in July, 2007. In this relationship, JAEA will support MFBR in terms of technical issues such as sharing the result of R&D.



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